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FUNGI PARASITIC ON THE TEA PLANT IN NORTH EAST INDIA

BY

A. C. TUNSTALL, B. SC.

Part VI.*

BASIDIOMYCETES—(continued.)

The fruit bodies of the more highly developed *Basidiomycetes* are the fungi which are most commonly noticed in everyday-life. The mushrooms are *Basidiomycetes*, so are the numerous species of bracket fungi which adorn fallen trees and are found clustered on wooden bridges, gates, etc.

There are two classes of *Basidiomycetes*. One, like Blister blight, has no special arrangement corresponding to a pycnidium or perithecium for the protection of its spores while they mature; the other has its spore-bearing surface covered by a skin until the spores are ripe.

Fungi of the former class, although their spore-bearing surfaces are not completely covered, possess numerous devices for the protection of their spores. In the mushrooms the spores are produced on plates arranged like the gills of a fish beneath a cap. In many of the bracket fungi the spores are borne on the inner linings of tubes. Besides affording protection to the spore-bearing layers these devices also increase the area without increasing to any great extent the quantity of supporting tissue.

FOMES LUCIDUS.

Of the higher *Basidiomycetes* one of importance to the tea planter is *Fomes lucidus*, a common cause of root disease. The fungus is very easily recognised by the bracket-shaped fruit bodies,

* Continued from page 16 of part I of 1915 of this Journal.

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which sometimes measure nine inches across. They are reddish-brown above and white beneath. Their under surfaces are covered with tiny pores, which are the ends of the tubes in which the spores are produced. The fruit body generally lies close to the surface of the soil, and thus, in spite of its size, frequently escapes notice. This fungus does not usually attack tea growing on a sandy soil but seems to prefer stiff clay tilas. It is easily eradicated by digging out and burning the dead plants, and care should be taken when doing so to remove all the dead wood from the soil.

No members of the *Basidiomycetes* whose spore-bearing surfaces are enclosed attack tea, but some of them are very commonly seen in the tea districts. The commonest of all is the puff-ball, a round white fungus which grows by the roadsides in the grass. When ripe the skin ruptures and the spores escape like a puff of smoke.

FUNGI IMPERFECTI.

This group is one into which all the fungi which do not fit into other groups are placed. As numbers of forms hitherto placed in this group have been proved to be merely stages in the life cycle of higher species, and many of its members are considered to be conidial forms of the *Ascomycetes* or *Basidiomycetes*, they are classed as *Fungi imperfecti*.

GREY BLIGHT.

Pestalozzia palmarum—one of the commonest members of this group—attacks tea, causing Grey blight. It usually attacks the older leaves, but is also sometimes found on the stems. The spores are elliptical and divided by transverse septa into segments. Three colourless hairs are borne at one end.

It is supposed that when a spore settles on the under surface of the tea leaf these hairlike projections, becoming entangled with the hairs on the epidermis of the leaf, keep it in position until the germ tube enters the tissue. The fungal hyphae kill the tissues, absorbing the contents of the cells, and after a time, which varies according to the climatic conditions, spores are formed.

They occur in clusters beneath the dead epidermis. When ripe the epidermis is ruptured and they escape. These clusters of spores are easily seen, without the aid of a microscope, as black spots. As a rule the fungus spreads in concentric rings, giving the diseased patches a characteristic appearance. *Pestalozzia palmarum* is exceedingly common in the jungle, where it usually lives on dead leaves. It is also a parasite on many common plants. As a general rule it does not attack vigorous healthy leaves, but confines its attention to old damaged ones or to those previously weakened by some other cause. For example, after a period of hot dry weather the fungus frequently attacks the margins of young immature leaves, and is one of the causes of Rim-blight.

It is practically impossible to eradicate this fungus by direct methods, as it is so common in the jungle. Good cultivation, pruning, and manuring, aided by a general spraying treatment, reduce the ravages of the blight to a minimum. Grey blight is present on all tea gardens, but as a rule does very little harm to those in a healthy condition.

DIE-BACK DISEASE.

Gleosporium sp.—Tea which has been weakened as a result of adverse conditions frequently suffers from this disease. The young shoots die back and the leaves fall off. Light brown dead patches are usually found on the leaves. Examination with the microscope shows numerous clusters of very small oval spores on the epidermis of the stem or leaf attacked by the disease. It would seem that more than one species of *Gleosporium* attack tea.

BROWN BLIGHT.

Colletotrichum camelliae.—The fungus which causes this blight resembles closely that causing Die-back, differing from some forms only in one respect, the presence of black hair-like structures between the spores.

Both Die-back disease and Brown blight are diseases of weak unhealthy plants. In almost every case where gardens have been badly attacked by these diseases general improvement of the soil

and other conditions has removed the trouble. Sometimes when it is impossible to remove the causal conditions in time to prevent serious loss of crop, applications of tonic spray fluids will be found beneficial. Further information regarding the treatment of Grey blight, Brown blight, and Die-back will be found in "Notes on the Spraying of Tea" pps. 27 and 29.

INTERNAL ROOT DISEASE.

Diplodia sp.—Disease of tea roots is caused by various species of *Diplodia* fungus. The commonest is *Botryodiplodia theabromae*. As a general rule infection of healthy plants takes place at a dead snag; and then enters the living wood, where it thrives. A plant may be affected for many months and yet continue to look healthy. A check, such as that caused by pruning, effects some change in the internal economy of the plant, and the fungus forsakes the woody portion of the roots and stems and attacks the growing layers, thus interfering with the transport of sap. The bush then dies suddenly. Externally the roots appear quite healthy but if they be cut length-ways black stains will be found in the wood. Some little time after the death of the plant the dead roots assume a sooty appearance. This is due to the formation of a large number of pycnidia (spore cases). These contain a large number of black elliptical two-celled spores called diplodia spores. In some species the pycnidia are smaller and are produced singly, but in the species mentioned above they are borne in clusters—hence the name botryodiplodia. The pycnidia resemble those produced by *Rosellinia*. Investigation of *Diplodia* root disease is proceeding, and the results will be published later in one of a series of pamphlets on tea roots which is now in preparation. At present the only remedy known for the disease is to dig out the dead plants and burn them before the pycnidia form.

NOTES ON INSECT PESTS OF GREEN MANURES AND SHADE TREES

BY

E. A. ANDREWS, B.A.

Part I.

Now that the growth of green manure crops and shade trees is becoming a generally recognised practice on tea estates, attention is being drawn to the insect pests of such crops, and several cases of serious damage being done to green crops have already been reported. As, up to the present, the publications of this Department contain no information on these pests, it is proposed to give, in this series of articles, information on the insects which are found to attack green manure crops and shade trees on the tea gardens of North-East India. That a knowledge of such pests will be of great use to the tea planter in the near future is certain. Mann, on page 191 of "The Tea Soils of North East India," records the failure of an attempt to grow Dhaincha (*Sesbania aculeata*) in Tezpur owing to insect attack, and in the summer of 1912 a crop of the same plant on a garden in the Duars was utterly destroyed by the caterpillar of a butterfly, *Terias hecabe*. It is earnestly hoped that planters will send to this Department specimens of any pests of green manures that may come under their notice, in order that our knowledge of such pests may be extended as rapidly as possible.

Cantharis hirticornis.—Haag.

This beetle belongs to the family *Meloidae* sub family *Cantharinae* (Blister beetles), and is very common in Assam, where it does a great deal of damage in vegetable gardens. It is an elongated, straight-sided beetle, about three quarters of an inch long, black, with a red head, which is joined to the body by a narrow neck,

and is bent down at right angles to the body. It has a pair of slender antennae, or horns, and long slender legs. The body is not so hard as in most beetles, and the wing cases, when closed, lie rather loosely on the back, as if they did not quite fit. The insect is a strong flyer, and may be seen flying about the garden during the day.

The life history of this beetle has not been worked out, but in the case of closely related species is somewhat as follows. The eggs are laid in large masses on the ground, and hatch out into small grubs which are exceedingly active, and run about on the surface of the soil until they find the egg-mass of a grasshopper, on which they feed. After a time the larva changes into a thickish sluggish grub, and probably pupates in the egg-mass or in the soil just below. During the young stages, therefore, the insect is in all probability beneficial.

This beetle is recorded from Assam as a pest of Dhaincha (*Sesbania aculeata*), eating the foliage of the young plants.

Catching with small nets is the best remedy. If the crop affected is planted in young tea, which is not to be plucked, in a fenced area, lead arsenate might be sprayed on to the plants. In other cases the only insecticide which can be safely applied is lead chromate, as the application of arsenic, while being inadvisable in the tea, might also lead to the death of cattle.

Diacrisia obliqua.—Wlk.

This is a moth belonging to the family *Arctiidae*. The wings are yellowish or pale buff colour, with a few black spots, and the body is crimson, with a row of black spots down the back and along each side. The length of the moth is about three quarters of an inch, the expanse of wing about an inch and a quarter.

The eggs are laid on the underside of the food plant in batches, and one female may lay from four hundred to a thousand eggs. These eggs take about four days to hatch, and give rise to small caterpillars, which are gregarious for the first few days and eat away the lower surface of the leaves. After a time the caterpillars separate and begin to spread from plant to plant, feed-

ing on the leaves as they go. When full grown the caterpillar is about an inch and a half long, with three pairs of true legs towards the front end of the body, four pairs of fleshy legs at about the middle, and a pair of fleshy legs, or claspers, on the hind segment. The general colour is orange, but the head and first three segments, and hind end of the body, are blackish. The whole of the body is covered with hairs. This stage lasts for about three weeks, and at the end of that time the caterpillar descends into the soil, sheds its hairs, and forms a reddish-brown chrysalis stage lasts for about ten days, at the end of which period the moth emerges, having completed its life cycle in about five weeks.

This pest was found to attack Soy bean (*Glycine soya*) and *Desmodium* *sp.* in the Jorhat district of Assam. Other green manures which it is known to attack are Sann hemp (*Crotalaria juncea*) and Groundnut (*Arachis hypogaea*.)

The caterpillar is subject to the attack of a hymenopterous parasite. If the pest is noticed in the early stages, when the young caterpillars are all together on the plant, it is quite easily collected. Lead chromate may be used as a spray. If the plants are badly attacked, they should be hoed in directly the caterpillars appear to have left them and gone into the ground to pupate. Leaving the plants to grow will only mean a further attack by the next brood, and by hoeing up the ground a large number of the chrysalides will be killed, and this will help to reduce the numbers of the pest in succeeding years.

Catopsilia pyranthe.—Linn.

This is a medium sized butterfly belonging to the family *Pieridae*, with a wing expanse of two to two and a half inches. It is white in colour, with a black spot at about the middle of the forewing, nearer to the front than to the hind edge. The front corner and outer edge of the forewing are suffused with black, and the outer edge of the hind wing has a narrow incomplete black border.

The egg is smooth, white, and torpedo-shaped, and is laid singly on the leaves and stems of the plant. The caterpillar is pale yellowish-green, with a pale yellow or white stripe along the

side, and a row of minute black shining tubercles above the stripe. The skin has a rough appearance. When full grown the caterpillar is about an inch and a half long. The pupa or chrysalis is green, and has a ridge extending the whole length of the body on each side, and a short keel on the back. It is attached to a stem of the plant by a small tuft of silk threads at the end, and a silk girdle which passes round the middle of the body and is fastened at each end to the stem. The butterflies emerged in the laboratory eight days after pupation in August.

The caterpillars were defoliating Sonaru trees (*Cassia fistula*) in the Jorhat district. They are also, known to attack *Sesbanias*, and probably feed on other *Leguminosae* also.

The Sonaru tree is usually grown more for ornament than for shade, and the trees could only be sprayed by means of a power sprayer. Should the insect turn its attention to *Sesbanias* it might be dealt with by means of a poison insecticide.

✓ *Terias hecabe*.—Linn.

This common butterfly also belongs to the family *Pieridae*. It is yellow in colour, with irregular dark brown to black edges to both fore and hind wings. The measurement across the wing from tip to tip is one and a half to two inches.

The egg is smooth, white, and shaped like a spindle, and is attached to the upper side of the leaves. The caterpillar is pale green, with a rough skin, and is slender in build. Along the side is a white stripe, and the body is covered with short scattered hairs, which appear to exude small drops of fluid. It is often very difficult to find, as it is practically of the same colour as the leaves of the plant. The chrysalis is slung from a stem of the plant in a manner similar to that of *Catopsilia pyranthe*, and is slender, somewhat spindle-shaped, and pale green in colour.

This insect has been reported from the Duars and Assam on Dhaincha (*Sesbania aculeata*). In bad attacks it will entirely defoliate the plants, leaving only the bare stems, and it will do this when the Dhaincha is as much as five feet high. It has also been reported from Assam as defoliating Sau trees (*Albizia stipulata*).

The control of this pest is a difficult matter. In the case of Dhaincha the plants might be sprayed with lead arsenate (if it can be done without spraying the tea also) or with lead chromate, but in the case of Sau trees a power sprayer would be necessary. To attempt to collect the pest is hopeless. Fortunately the attacks of the pest seem to be sporadic.

Coptosoma nazirae.—Atk.

This insect is a sucking bug belonging to the family *Pentatomidae*, sub-family *Plataspidae*. It feeds by sucking the juices from the young shoots and leaves of the plant, producing, when present in large numbers, a rather stunted growth. It is a small, globular insect, with an appearance resembling a small "lady bird" beetle. On close examination, however, it will be seen that the back is in one piece, not divided down the middle as in the lady birds. In colour it is shining black, with a narrow yellow rim to the edge of the body, and two yellow spots on the back just before the middle. The body is black beneath, with yellowish legs, and at the front end, lying against the under surface, can be seen the fine yellow proboscis by means of which the insect pierces the stem or leaf and sucks up the plant juices. The insect is about an eighth of an inch in length and breadth.

The eggs are laid in a double row on the leaves, and from them emerge small bugs, having an appearance rather similar to the adult, which suck the leaves of the plant in the same way. There is no chrysalis stage. The young insects go through a series of moults, the final moult, which takes place in a similar manner to the others, resulting in the emergence of the adult.

The insect is found in large numbers on Boga medeloa (*Tephrosia candida*).

Insecticides are of little or no value against this insect. The only remedy, should the pest become serious, would be to collect the insects.

Eriochiton theae.—Green.

This is a scale insect, belonging to the family *Coccidae*. There are two kinds of scales, the female scales, which are attached

to the stems and twigs, and the male scales, which are to be found on the under side of the leaves. The female scale is oval, and strongly convex, about one eighth of an inch long by one tenth of an inch broad, but some species may be a little larger. It has a whitish waxy covering which has the appearance of being composed of six irregular longitudinal rows of polygonal pieces, and is composed of felted white hairs which are conspicuous round the edge of the scale. It is attached closely to the twig, and lies with its long axis along the direction of the twig. The male scales are very much smaller, flattened, and of an elongated oval shape. They are covered with wax of a dirty white colour, and are to be found on the under-side of the leaves, chiefly along the ribs and veins. They feed by sucking the juices of the plant.

The eggs, which are exceedingly small, ovoid in form, and of a dirty orange colour, are contained beneath the female scale. They hatch into minute orange-coloured active larvae, which run about the plant until they find a suitable situation, when they settle down, begin the secretion of wax, and gradually take on the form of the scale. The female never leaves the scale, but the male eventually emerges from its scale as a minute red insect with one pair of transparent wings and a ring of peculiar simple eyes round the head. The hind end of the body is provided with a spine-like process.

This insect has long been known as a pest of tea, but recently specimens have been received from the Western Duars on Dadap (*Erythrina indica*) and from the Eastern Duars on Arhar dal (*Eajanus indicus*). In both cases the pest commenced on the green manure plant and later attacked the tea.

When the pest occurs on *Erythrina* the procedure suggested in "Notes on the Spraying of Tea," page 16, may be followed but in the case of *Cajanus indicus* emulsion soda could not be applied, and the treatment would have to be confined to spraying with rosin solution. Since the publication of the above pamphlet notice has been received of an insecticide which is said to have been used with success against scale insects in Italy, which might be well worth a trial. This insecticide consists of a mixture of heavy tar-oil and Diesel motor oil in equal parts, emulsified with soapy water.

A SWARM OF LOCUSTS IN THE DARJEELING AND TERAJ DISTRICTS.

Whilst on tour this summer in the Terai and Darjeeling the Entomologist had the opportunity of observing the effects of the visit of a swarm of locusts to the tea districts, and an account of the observations made may be of interest.

The attention of the writer was first attracted to the swarm while at Ord Terai Tea Estate, on the eighth of July, at about 2-30 p. m., by the sight of large numbers of the insects in the bungalow compound. On looking up, the insects were seen to be passing over head in a vast swarm, flying very high and coming from the South-West, from which direction a steady breeze was blowing. The sky was overcast and dull, and the swarm could not be seen very distinctly, but the moving column was of such width that it extended, to right and left, almost half way to the horizon. Some of the insects, as mentioned above, settled in the bungalow compound and in the neighbouring tea, but though they must have been settling in hundreds, produced no appreciable diminution of the numbers of the main body. They were quite sufficient in numbers, however, to make an appreciable difference to the flora of the compound. A hedge of *Boga medeloa* was stripped of its leaves at an enormous rate, and a *Hibiscus* bush was attacked voraciously. The grass in the compound was also eaten, and even leaves of pineapple were attacked. The locusts, in fact, were settling anywhere and everywhere. Examination of the tea round the bungalow, however, showed that the damage being done to the tea was very small, and confined to the old leaves, which were in a few cases half eaten. Many of the insects fell victims to the omnivorous "moorghie," and a myna was seen to catch one on the wing. About an hour to an hour and a half after the swarm had been first observed, when the writer left Ord Terai for Panighatta Tea Estate, the locusts were still passing overhead in apparently un-

diminished numbers. At Panighatta the sight was a wonderful one. Thousands of the insects were swarming round the factory, a great many of them settling on the factory roof, where they were being gleefully captured by Paharia boys. It was curious to note that the insects settled on the factory roof, and not on the roof of a withering shed close by. It may be supposed that the heat of the factory roof attracted the insects, but the factory roof was red, while the roof of the withering shed was of unpainted galvanized iron; also, the roof of the bungalow at Ord Terai was painted red, and although the locusts had descended around the bungalow, and were passing over the road to Panighatta, very few were to be seen flying low between the two places. The bulk of the swarm passed beyond the factory, but seemed to be descending to find a suitable resting place for the night.

Next morning the garden was a wonderful sight. The tea bushes, covered with locusts, resembled nothing so much as a plantation of rhododendron covered with bloom. In spite of the insects, however, the old tea was scarcely affected, although an appreciable difference had been made in the height of the jungle in places, and Siris, Dadap, and Sal trees had been almost stripped in many cases. The bulk of the damage done to the tea appeared to be due to the enormous amount of excreta on the leaves. One noticeable feature was that the visitors seemed to have cut or broken off more than they could eat, a great deal of uneaten foliage being on the ground, and one case was noticed where a weak branch of a Siris tree had been broken off, probably by the weight of the mass of locusts settling thereon. In places the insects were three or four deep on the roads, flying into one's face as one walked along, and almost completely obscuring the view of the tea. They are, on the whole, very easily disturbed, but large numbers allowed themselves to be trodden on.

The locusts had also settled in the gardens further east, and on the morning of the 10th a few were still to be seen at New Chumta Tea Estate. At about 5 P.M., on the same day, the wanderers were to be seen, in greatly reduced numbers, around Gyabari (3,516 feet), on the Darjeeling-Himalayan Railway, and for a short distance above this place, but they did not

appear to reach Kurseong (4,860 feet) until the evening of the next day. On the 13th the locusts had flown as high as Ghoom, (4,408 feet) and Darjeeling, (7,002 feet) and when the writer left the district on the 30th of the month a few were still to be seen below Sonada (6,552 feet). During the period referred to the hills were, for the most part, shrouded in mist, and when this cleared and the sun came out the insects began to rise, but fell back to the valleys as the mist came down again. Although, in most cases, the locusts did little damage to the tea, yet in some places, more especially in young tea, they did a certain amount of harm by what Peal* very aptly described as "mouthing" the young shoots. Specimens of the insect were collected, which proved to be the North-West or Migratory Locust, *Acridium reginum* Oliv.†

Some account of this insect may be of interest.

Its home is in the sandy deserts to the west of Afghanistan and Baluchistan, whence it periodically swarms over India. The consensus of opinion amongst the planters of the Darjeeling-Teraï seemed to be that the last swarm to invade that district appeared in 1891, although one or two stated that there had been a small swarm since.‡ Stebbing§ gives the average number of years that elapses between two invasions as eleven, while Webb|| from observations made in Baluchistan, puts the interval between the swarms at from six to eight years, the swarms appearing after years of good rainfall.

The eggs are laid in a vertical position in holes in the ground, in clusters, being attached to one another by some adhesive substance. They require moisture and a high temperature combined,

*Watt and Mann; "The Pests and Blights of the Tea Plant," 2nd ed., 1903, p. 244.

† Kirby, in the volume on *Acridiidae* of the "Fauna of British India" series, describes this insect under the name of *Schistocerca tatarica* Linn. It is, however, perhaps better known in India under the name given above.

‡ Stebbing, in "A Manual of Forest Zoology for India," p. 40, states that a swarm spread as far east as the Brahmaputra river in 1901.

§ "A Manual of Forest Zoology for India," p. 39.

|| "The Agricultural Journal of India" vol. X, 1915, p. 159.

to hatch, and given favourable conditions, hatch in as short a period as twelve days, although with less favourable conditions they require longer, and may remain dormant for years. The newly hatched locust takes the form of a small wingless grass-hopper, which is at first red in colour, but rapidly turns black after reaching the surface of the ground, and is commonly known as a "hopper."

The hoppers pack together in dense masses, and eat all before them. After several moults the winged adult emerges. This is about two and a half inches long, and of a reddish purple colour at first, turning yellow when about to lay eggs. The forewings are spotted and marked with black, and the upper part of the neck is grooved with fine lines. The adults feed for a time, until, one day when there is a strong breeze blowing, they launch themselves into the air as a swarm, the wind playing a great part in determining the path taken by insects. What happens to successive swarms is not quite certain. The parent swarm, coming from the great desert of the North-West, is known to get as far as the Punjab, where eggs are laid which give rise to further swarms, which, continuing in the direction taken by the first swarm, but influenced by the wind, may spread as far south as Madras or east beyond the Brahmaputra.* Some of the locusts are supposed to find their way back, eventually, to their home in the north-west, but how they get there is unknown. Those which pass over into the hills of Sikkim and Bhutan never return.

The cause of these swarms has been the subject of much discussion. It is known, however, that the eggs, which are laid in clusters of 70 to 100, do not hatch at the same time, but in succession, and only under certain conditions of moisture and temperature, and that they can remain dormant, in many cases, for years. It is conceivable, then, that in a dry season when the soil only contains a sufficient amount of moisture for short periods at a time, only a small proportion of the eggs in a cluster will attain maturity, and the locusts will be comparatively few

* There is a specimen in the Indian Tea Association's collection at Tocklai, which[†] was collected at Kanny Koory, Silchar, in October 1906.

in number. In a wet year, however, when soil conditions are favourable for longer periods at a time, most of the eggs will hatch, and the numbers of the insects will be enormous. This would seem to explain the fact of the swarms appearing after wet years.

E. A. A.

NOTE ON THE APPLICATION OF MANURES.

The following notes amplify what has been said about the application of manures in the recently published pamphlet entitled "Suggestions for the manurial treatment of tea soils."

All manures are likely to give their maximum effect if thoroughly incorporated with, say, the top six to nine inches of soil. The most thorough mixing is obtained by the use of a fork hoe, and therefore for the purpose of hoeing in manures the fork-hoe is preferable to the flat hoe.

Forking of manure into the soil round the bushes or placing it in trenches round each bush is not recommended, except in special cases for reasons which have been given in the above mentioned pamphlet. (See page 22.)

CATTLE MANURE.

Should be applied either :—

(a) broadcasted.

(b) in trenches.

or (c) in pits.

(a) Cattle manure may be applied broadcasted, at any time of year, but after application the manure should be hoed in with an interval of not longer than a few days and sooner if possible.

(b) Cattle manure should be put into trenches, during the cold weather and as shortly as possible before the trenches are filled in.

(c) The use of cattle manure in pits, should be confined to the cases of infillings and of planting young shade trees, and the time of application must depend upon the time of year when these are planted.

LIME.

Lime should be applied when the soil is fairly dry. This refers particularly to quick and slaked lime. The reason is that if

the soil is wet at the time of application the powdered lime packs into lumps which become converted into carbonate of lime externally and dissolve but slowly. It is advisable therefore to apply lime during the cold weather. In cases where lime is being used in large quantities per acre, it should be applied early in the cold weather so as to be distributed by the deep as well as by succeeding light hoes. When smaller quantities are being applied it may be put on before the first light hoe.

BASIC SLAG.

Basic slag should if possible be used in conjunction with treatment of the same area of tea with nitrogenous and organic manures or green crops. If used with a green crop it should be applied before the sowing of the latter. If used with organic nitrogenous manures it should be applied several weeks previous to them. It can be applied simultaneously with lime and nitrolim.

ANIMAL MEALS.

On soils on which these manures give the best results, their chief value is obtained in one season, which points to rapid nitrification of the nitrogenous constituents. Consequently in these cases it is only necessary that the manures should be applied sufficiently early to anticipate the first flush. On some soils it has been found that slightly better results are obtained by applying the manures earlier in the cold weather. As a general rule these manures should be applied at any time during the early spring, but on no account later than the time of the second light hoe. On light soils a second application can be made later in the season.

OILCAKES.

The same remarks apply here.

NITROLIM.

This should be applied early enough to permit of reaction with the soil before the tea bushes begin to flush. It does not always decompose quickly and should therefore be applied fairly early in the cold weather. It can conveniently be applied before the deep hoe. It can be applied simultaneously with lime and basic slag.

SULPHATE OF POTASH.

This being soluble can be distributed easily in wet weather and for the same reason is immediately available for the bushes. It can therefore be applied as soon as the soil is moist, early in the season, but it can also be given as late as, say, the middle of August. If it is being applied in small quantities as part of a mixture there is no objection to applying it in dry weather. It is preferable to apply it in divided doses. It should always be applied broadcasted.

SULPHATE OF AMMONIA.

This being soluble and also rapidly converted into nitrates, it can be applied suitably any time of year up to, say, the middle of August. It is most conveniently distributed when the soil is damp. It is best to apply it after rain and about the beginning of the flushing season. It is preferable to apply it in divided doses. It should always be applied broadcasted.

NITRATES (OF SODA, POTASH, LIME, AND AMMONIA).

These form the most soluble class of manures, and the most readily available. They should be forked in immediately after application. Periods when heavy rain is expected should be avoided if possible on account of the readiness with which nitrates are washed out of the soil. They are more quickly distributed, however, when the soil is damp than when it is dry. To avoid loss by wash, application of a small quantity at a time should be made if possible, so that the total dressing decided on should be given usually in two or even three applications at intervals spread over the season.

SUPERPHOSPHATE.

Superphosphates, being water-soluble manures, can easily be distributed in wet weather, and there is at no time any great danger of their being washed out if they are carefully forked in after application, because the soluble phosphates contained in them are rapidly precipitated in the soil.

G. D. H.



A plot of *Desmodium tortuosum* at the Tocklai Experimental Station.

GREEN MANURES

BY

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AND

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Part III.

DESMODIUM TORTUOSUM.

A little over two years ago a small packet of seeds of this plant was received from the Instructor in Tropical Agriculture, Cairns, Queensland. The seeds were planted out in a carefully prepared seed-bed, but, in spite of every attention, the resulting plants were very small and it was decided that as a green manure crop they were a complete failure. As an experiment however, a plot was planted out with cuttings from the original plants. The cuttings grew splendidly, producing plants over six feet high. In the cold weather these seeded and the seed was collected and stored. This year the seed was sown in the spring. About ten weeks after, it was apparent that the plants were too close together and they were thinned out. The thinnings were weighed and were found to exceed a ton per acre. It is now, (four months after sowing,) the heaviest crop on the station.

The plant has large clover-like leaves which are continually falling and being replaced by new ones. At four months there is only a bunch of leaves on the top of a stem eight feet high, all the lower leaves having fallen and provided a very large weight of green matter already. Small, pale purple, pea-shaped flowers are produced about October and continue throughout the cold weather. The name *tortuosum* is derived from the twisted pods in which the seed is borne. The seed is small and of a pale

yellow colour. The roots are covered with nodules and strike deeply into the soil.

This plant resists drought very well and will grow throughout the cold weather without attention. The young stems are less woody than those of Sann hemp, but when older resemble those of Arhar dal.

For green manuring purposes the crop should be sown early in the rains at the rate of from 8 to 10 seers per acre. It would be ready to hoe in in about ten weeks.

The plant is used in Australia as a fodder plant, where it is known as "beggar's grass." It is said to thrive best on poor sandy soil. All Australian seedsmen supply it. We have no reliable information concerning the present price of the seed, but some time ago it was quoted at six shillings a pound in London.

As the plant fruits very freely, and further, as the crop from acclimatised seed is likely to prove so much more satisfactory than that from seed freshly imported, we would suggest that planters desirous of using this crop should obtain a few pounds of seed only and plant it out for seed. The most economical way would be to sow it in seed-beds protected from the heavy rain in June and then plant out cuttings in July, obtaining the seed from these plants throughout the cold weather. The cuttings should be planted for this purpose about one foot apart.

RECENT TOURS.

CHIEF SCIENTIFIC OFFICER.

On the 14th of May the Chief Scientific Officer left Calcutta for Cachar, this being the first occasion on which he has had the opportunity of seeing the majority of the representative gardens of the North Cachar plateau. He visited first the Happy Valley district where a meeting was held at Koombhir on the 16th, at which seven planters were present. On the following day he saw Koombhir Estate in the morning and went to Pathecherra in the afternoon. On the 18th he went to Kumbhirgram and on the following day to Palarbund and on to Dewan in the Lakhimpur district on the 20th, where a meeting was held the same day attended by eight planters. After visiting several of the gardens of the Tarapore Tea Co. the Chief Scientific Officer proceeded on the 22nd to Dilkhosh and on the following day to Alyne returning to Dewan that evening. On the 24th he left for Palarbund and on the next day for Dooloo, and after visiting Rampore and Koreil proceeded to Kalline on the 28th where a meeting was held which was attended by seven planters. On the following day he visited Craig Park leaving the North Cachar district for Assam on the 30th.

The soils of the North Cachar plateau appear to be more closely allied in character, and possibly in the nature of their origin, to those of the Red Banks of the Dooars and Tezpur than to the majority of the soils of Assam. They are responsive to manurial treatment, though bushes deteriorate very rapidly on these soils if proper attention is not given to them. Red rust and mites of different species are particularly noticeable on older sections of gardens on these soils, a feature which these and Red Bank soils have in common. The majority of the soils on this plateau would probably be benefitted very considerably by the application of lime, and, in spite of their high position, good drainage is very necessary. A particular feature of the tea of this plateau appears to be the very

bad condition of the frames of bushes which yet yield a fairly good crop. The remarks which were made under the heading "Recent Tours" in the last issue of the Quarterly Journal, with regard to the necessity for improved pruning in the Surma Valley, was the basis of the chief discussions of a general nature with planters in these districts, and the opportunity was also taken of demonstrating methods of pruning which are likely to be useful in remedying bushes without loss of useful branches.

It appears that unpruned tea does well in this district and the suggestion was put forward that a larger part of total area should be left unpruned on each garden with a view to having more labour available for carrying out better pruning on the remainder of the garden.

The prevalence of scarlet mite was noted throughout the Happy Valley and North Lakhimpore districts.

Speaking generally it appears that this tract of soil is one capable of giving very much better results than are at present obtained, but this can only be done by improved and more intensive treatment. Deterioration shows itself very quickly where intensive work is neglected.

On the 3rd July the Chief Scientific Officer left Calcutta for the Darjeeling district, stopping first at Kurseong where he visited two estates. On the 9th he proceeded to Darjeeling and on the 10th to Thurbo garden in the Rungbung district, returning to Darjeeling on the 12th. On the 15th he went to Tumsong returning to Darjeeling the next day. On the 18th he went to visit the four gardens below the Hoom cantonment returning to Darjeeling on the 23rd. On the 24th he attended a Committee Meeting of the Darjeeling Planters' Association and afterwards gave a joint address with the Entomologist at a General Meeting of that Association. On the 25th he proceeded to Bannockburn and Mineral Springs, and from there to Pubong, Dooteriah, Moondakotee, and Margaret's Hope, arriving at Nurbong on the afternoon of the 29th and leaving the district for Assam on the following day.

The question of pruning was again discussed in detail with planters, and in general terms in the address given in Darjeeling on

the 24th of July. Attention was again directed to the impossibility of getting the best results, or of adequately coping with pests and blights, while so much of the tea in the district is pruned in the way it is at present. The congested condition of a very large percentage of the total number of bushes is deplorable, and while adding nothing to quality militates very seriously against the yield and the general health of estates, and against the object every planter should have in view—*increase of profits per acre*.

The Chief Scientific Officer and Entomologist were both impressed by an objectionable feature of *Erythrinas* (Fullidha) at this time of year, when rain and mist is frequent, namely the danger arising from the falling leaves which lie rotting in and on the bushes for days together. This is more than likely to aggravate attacks of Blister, Grey, and other blights.

The soils of the district are to be investigated at the beginning of next year in connection with the soil survey, but it may be recorded here that there are undoubtedly many different types in this district, depending on different mechanical composition. A stiff red-yellow clay which crops out on ridges and in places which have suffered seriously from erosion, appears to be prevalent chiefly at higher elevations. In other places a shaley soil formed directly from underlying micaceous rock is a prevailing type, while in places which are sufficiently level to allow of the building up of strata of deep rich transported soils of different types, the deposits afford extraordinarily fertile media for patches of tea which should give big yields.

ENTOMOLOGIST.

During the month of July the Entomologist undertook an advisory tour in the Darjeeling and Terai districts.

The period from the 2nd to the 9th was spent in the Terai where an address was given on the 4th at the Bendubi Club to seven planters, dealing mainly with the question of mosquito blight. Most of the gardens were just beginning to come through a sharp attack of mosquito, but were being handicapped by bad growing weather, and, taken on the whole, places in which hard plucking had not been resorted to were coming away better than

those which had been plucked hard. As the bushes which were flushing well were, however, much stronger and healthier than the others, this may have been mere coincidence. A rough test was made in the field to get some idea of the value of hard plucking, so far as the collection of eggs is concerned, at the then present juncture, when the bushes were just beginning to come through. Shoots were plucked from bushes on a badly affected area in the same way that hard plucking is carried out there in practice, and it was found that the percentage of plucked shoots containing eggs was slightly under two.

A feature in some of the worst affected blocks in the district was that the bushes seemed to be checked, and make little or no attempt to produce even buds for some time. In other blocks, it was to be noted that while pruned tea grew fairly strongly, parts of the blocks left unpruned made little or no effort to move. Such a state of affairs would seem to indicate something wrong with the soil conditions, apart from the presence of the tea mosquito, and in most cases, certainly, there seemed to be room for improvement in this direction. Further, attempts to improve the condition of both the soil and the bushes, by attention to cultivation, manuring, and pruning, could be seen to have resulted in a marked increase in the resistance of the bushes to mosquito blight attack. This is, perhaps only to be expected, because an unhealthy bush cannot resist the attacks of its particular parasites any more than an unhealthy man is able to resist the attack of, say, malarial parasites, and in this connection one would like to point out that full benefit cannot be expected to accrue from any method of insect control if the bushes themselves are not in a fit condition to take their part in the battle. A doctor may kill the parasites which have got into a man's system, but no beneficial results will accrue if the man be allowed to die from want of proper food. On the contrary, if the man be properly nourished the doctor will have less difficulty in dealing with the disease. While in this district the writer's attention was drawn to a so-called "red *jat*" of the tea mosquito, numbers of which were being brought in by the children who were catching mosquitos in the tea. These red insects proved to be young specimens of a *Reduviid* bug belonging to the genus *Harpactor*, "

genus of bugs predaceous on other insects. The children should be instructed not to catch these. On one garden the number of *Harpactor* reached, on occasion, twenty five per cent of the whole catch. Specimens of this bug have since been received at this laboratory from the Western and Central Duars.

While the Entomologist was in this district a swarm of locusts appeared, a short article on which will be found in another place in this number of the Journal.

Kurseong was visited during the 11th to the 12th of the month, but the Entomologist only had the opportunity of seeing one garden in this district. On the 13th that officer visited Darjeeling to consult with the Chief Scientific Officer as to arrangements to be made for touring in certain of the Darjeeling districts, previous arrangements having been upset by the alteration of the date of the meeting of the Darjeeling Planters' Association. From Darjeeling he visited the Teesta Valley, from the 14th to the 18th, the Sonada Valley from the 19th to the 21st, and the Nagri Valley on the 22nd and 23rd, returning to Darjeeling to attend an Extraordinary General Meeting of the Darjeeling Planters' Association on the 24th, at which he delivered an address. In the few days remaining to the end of the month the Entomologist visited several gardens near Darjeeling and Sonada, and then returned to Tocklai. Thrips attack was almost over at this time, and Green fly in evidence. Around Lebong the Fullidha (Dadap) trees were found to be attacked by an insect closely resembling the Tea Green Fly (*Empoasca flavescens*), but which microscopic examination has shown to be, not the tea green fly, but a species of *Empoasca*, bearing more resemblance, so far as wing venation is concerned, to another species of *Empoasca* (*Empoasca notata*). The eggs of this insect are pale yellow, smooth, cylindrical, and about a millimetre in length, and are laid in groups, on the under surface of the leaf along the sides of the leaf-ribs. When hatched, the insects seem to be gregarious, and the undersides of the leaves were covered with them, in all stages, from the newly hatched larva to the adult. The leaf is attacked on the under surface, and, as a result of the attack, becomes covered with pale blotches on the upper surface. Later the blotches turn yellow, and

eventually the whole leaf becomes yellow and dies back. The young shoots and leaves also tend to become stunted. This pest, owing to its gregarious habit, and owing to the fact that it crowds on to the lower surface of the broad Fullidha leaves, should be quite easily dealt with by a good contact insecticide sprayed from below. A good kerosene emulsion or potassium sulphide is recommended for the purpose. (see "Notes on the Spraying of Tea.")

On a few of the higher gardens scale insects of various kinds appeared to be doing a certain amount of harm, and places were seen where a small black ant had done damage to the growing shoots in the early part of the season.

NOTES.

Mistletoe.—Attention is drawn to the importance of cutting out *Loranthus* sp. (rogamulla or mistletoe) from tea seed trees as soon as possible in the autumn. This parasitic plant is now in flower and it is necessary to remove it from the branches of the trees before its seeds are ripe enough to be attractive to birds. (See the "Memorandum regarding the Mycologist's tour in Cachar and Sylhet to study seed gardens" p. 34 in Pt. II, of 1915 of this Journal.)

Termites.—Rev. J. Assmuth, s. j. contributes an interesting paper to the Journal of the Bombay Natural History Society, Vol. XXIII, 1915 No. 4, pp. 690-694, on "Indian Wood-Destroying "White Ants." As a result of investigations carried out in the provinces of Bengal, Behar and Orissa, Bombay, and Madras, he concludes that the termites doing damage to the wood of buildings in British India are confined to three species, *Leucotermes indicola*, *Coptotermes heimi*, and *Odontotermes fæa*, though it seems possible that in Sind a species of *Microtermes* has also acquired the habit. Wood-destroying termites were not found, in the Ghats of South Canara and Mysore, at a higher elevation than 3-4000 feet above sea-level. "The task of removing dry wood and thus "making room for fresh growth which is so effectively carried on "by wood-eating White Ants in the lower parts of the Ghats, has, "in the extensive forests covering the heights above 4000 feet, "apparently devolved on larvæ of various kinds of *Coleoptera** "(*Buprestidae*, *Longicornia*, etc.)." At the end of his paper the author discusses the question whether Termites destroy live plants, and his remarks in this connection are quoted in extenso.

"I add a few remarks referring to the moot point, whether termites destroy live plants and trees. I can only repeat what I wrote in my previous paper (l. c. p. 381, foot note): none of the wood-destroyers I have seen feed on

* Beetles.

live plant tissue. Wherever I came across green plants or trees infested by termites—and I have examined a good many—I could always ascertain that only dry and decaying portions of wood, or else mosses and lichens growing on the surface of the bark, were being devoured by the white ants; where the live tissue began, the tunnels and burrows of the termites ceased.

“I am glad to be able to quote in confirmation of my views the opinion of Mr. A. V. D. Poorten, a Ceylon planter of large experience in cocoanut, etc., cultivation, whose acquaintance I made last May. In the course of our conversation he told me—quite unsolicited on my part—he was convinced that white ants never started an attack on healthy trees. Where he had found them feeding on trees, the first injuries could, as a rule, be traced to some other causes; the termites had put in their appearance only later on to complete the destruction of the already diseased portion of the tree.

“The following significant fact may throw some light on the belief of many people in India that termites destroy live plants. During the last two years insects labelled “white ants, very injurious to crops,” were sent to me from three different places, *viz.*, Ranchi, Ahmednagar, and Anand (Nos. 422, 108, and 596 of my collection). Examination of the specimens received showed however that none of them were white ants, but all belonged to a species of light-brown or yellowish genuine ants (*Formicide*) of the *Dorylus* tribe. This ant may well be mistaken for a termite by a casual observer.

“Until, therefore, convincing evidence to the contrary is produced I hold that the termites of the Indian continent—of others I have no practical experience—are innocent of the damages to crops or live plants so often attributed to them. Either the plants were already diseased when falling a prey to the white ants, or else the culprit is not a ‘white ant,’ but a ‘real ant.’”

Pests of Tea in Ceylon.—The following is a list, taken from the Review of Applied "Entomology" for April 1915, of tea pests recently recorded in Ceylon.

The moths *Brachyzyttarus subteralbatus* and *Homona coffearia*.

The butterfly *Rapala schistacea* feeds on the flowers.

The weevil *Astycus immunis* eats the young shoots as they come out after pruning.

The bug *Callicratides rama*, sucks the young flush, causing brown spots on the leaves.

The bugs *Riptortus pedestris* and *Riptortus fuscus* suck the young unopened leaves or the veins of older leaves.

A thrips feeds in colonies on the older leaves.

The scale insects *Saissetia hemisphærica* (*Lecanium hemisphericum*) *Coccus viridis*, *Aspidiotus rapae* (*camelliae*) a species of *Lecanium*, and a new species, *Ripersia theae*, which covers the twigs in the same way as mealy bug.

A small beetle, probably *Lasioderma testacea*, feeds on made tea.

Euprætis ? atomaria.

Insect Pests of Green Manures in Ceylon.—We give below a list of insects which have recently been reported by the late Mr. Rutherford as pests of green manures in Ceylon.

Acacia decurrens—

Euproctis scintillans Wlk, (*Lymantriidae*).

Tortrix sp. (*Tortricidae*).

Albizia sp.—

Orgyia postica (*Lymantriidae*).

Crotalaria striata—

Aulacaspis pentagona, Yarg. (*Coccidae*).

Hemichionaspis minor, Mask. („).

Lepidosaphes ? gloveri Pack („).

Leptocentrus ? substitutus (*Membracidae*).

Ragnus importunitas Dist. (*Capsidae*).

The larva of a small fly, probably an *Agromyzid*.

Argina ? *syringa*.

A *Tineid* caterpillar which destroys the seeds.

Desmodium cephalotes—

Xyleborus sp. (*Ipidæ*).

Erythrina sp.—

Taragama dorsalis Wlk. (*Lasiocampidæ*).

Eupterote petosiris Cram (*Eupterotidæ*).

Eupterote fabia Cram (*Eupterotidæ*).

Orgyia postica Wlk. (*Lymantriidæ*).

Terastia meticulosalis Guen. (*Pyrallidæ*).

Cyclopelta siccifolia Westw. (*Pentatcmidæ*).

Lepidosaphes erythrinæ Ruth. (*Coccidæ*).

Leuccena glauca—

Aspidiotus lataniæ Sign. (*Coccidæ*).

Tephrosia candida—

Pseudococcus virgatus Ckll. (*Coccidæ*).

Cerococcus sp. (*Coccidæ*).

Gargara mixta (*Membracidæ*).

Xyleborus fornicatus (*Ipidæ*).
